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Device for internal high pressure forming

5 The present invention relates to a device for internal high pressure forming according to the preamble of claim 1.

10 A method and a device for the internal high pressure forming of a hollow profile closed at the periphery has been disclosed by the German Patent Application still not published at the time of the present application and having the official reference 103 49 699.8 dated October 24, 2003. The known device has an internal high  
15 pressure forming tool with a sealing arrangement which contains an axial punch having a section plunging into the hollow profile for holding and sealing an end of the hollow profile, this end projecting from the impression of the forming tool. Furthermore, a unit for  
20 generating a high fluid pressure is provided for expanding the hollow profile by means of fluidic internal high pressure. Owing to the fact that an outside diameter of the axial punch on the plunging section is equal to or falls slightly below the inside  
25 diameter of the hollow profile end, and owing to the fact that the sealing arrangement contains at least one clamping jaw and a pressing element which, when the section of the axial punch has plunged in, presses radially on the hollow profile end, said clamping jaw  
30 fixes the hollow profile end in position. These measures prevent the hollow profile blank from being able to be pulled off the axial punch during the internal high pressure forming process and thus prevent its sealing effect from being reduced or even  
35 completely neutralized. Since the hollow profile blank, on account of the firm, axially immovable hold at the end, cannot be drawn into the impression during the forming, firstly the original overall length of the hollow profile blank is unaffected by the forming and

secondly no material of the hollow profile end can subsequently flow from the end into the mold space, so that, in particular in the case of long forming sections, a largely uniform distribution of the wall thickness can be achieved at each point of the hollow profile blank.

EP 1 152 843 B1 discloses a device for the internal high pressure forming of a hollow profile as defined in the preamble, which device has a forming tool, a sealing arrangement for holding and sealing an end of the hollow profile, this end projecting from the impression of the forming tool. The sealing arrangement is formed by a section of an axial punch, this section plunging into the hollow profile, and by at least one clamping jaw which, when the section of the axial punch has plunged in, presses radially from outside on the hollow profile end in such a way that the clamping jaw fixes the latter in position. The clamping jaw is connected to an actuator which drives it for displacing it only radially to the hollow profile axis.

DE 197 51 407 C1 discloses a device for hydraulically sealing a hollow profile. The device has a die and a clamping and feed unit and also a plurality of sealing elements closing the hollow profile. In the region of the sealing location, the die consisting of two die halves has, on the inside, a respective rounded bulged section extending radially inward over the periphery, the clamping and feed unit being provided with an axially movable mandrel which can be pushed into the hollow profile by means of a push-pull element. This mandrel is positioned with respect to the die in such a way that the bulged sections of the die lie such that they correspond to a mandrel section of corresponding design. Since the distance from the tube end is therefore not limited, sealing at any desired location in the tool is possible.

DE 38 20 952 C2 discloses a device for hydraulically expanding metallic hollow profiles generally open at end faces. The open end faces in this case are closed  
5 by rigid sealing heads which surround the inner or outer surface of the hollow profile in a close-fitting manner but at a slight distance apart. A sealing gap in between is sealed off in an elastic sealing ring which is designed as a hollow body and to which internal  
10 pressure can be applied. In addition, the sealing ring is enclosed in the sealing head in such a way that, as a result of the internal pressure, it can expand only in the direction of the outer or inner surface of the hollow profile to be sealed and comes into tight  
15 contact with the latter. The result of the enclosing of the sealing ring is therefore that the elastic material cannot give way laterally. Since, furthermore, the hydraulic expansion pressure is also applied in the sealing gap, provision is made for the internal  
20 pressure in the sealing ring to always be kept so far above this expansion pressure that the contact pressure of the sealing ring on the surface of the hollow profile is always above the expansion pressure and thus reliable sealing is ensured.

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DE 197 33 473 A1 discloses a method and a device for connecting a hollow-cylindrical air/fuel-ratio detector holder to an exhaust pipe provided with an opening for admitting exhaust gas to the air/fuel-ratio detector  
30 fastened in the holder. In this case, the method uses the internal high pressure technique for connecting the air/fuel-ratio detector holder.

In this case, by means of internal high pressure, the  
35 contour of the exhaust pipe is adapted in a simple manner to the bearing contour of the lateral surface of the holder at the location at which the future bearing surface of the holder is provided. The connection of

the lateral surface of the holder to the exhaust pipe saves construction space, the holder, at this location, being virtually sunk into the exhaust pipe, but at least into the pipe wall.

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The present invention deals with the problem of specifying an improved embodiment for a device for internal high pressure forming of the type mentioned at the beginning, which embodiment ensures in particular reliable holding and sealing of the semi-finished ends of the hollow profile and at the same time enables high-quality components formed by internal high pressure to be produced.

15 This problem is solved according to the invention by the subject matter of independent claim 1. Advantageous embodiments are the subject matter of the dependent claims.

20 The invention is based on the general idea, in a device for the internal high pressure forming of a hollow profile, which device has a sealing arrangement for holding and sealing an end of the hollow profile, this end projecting from an impression of the forming tool,  
25 of providing an actuator which drives a clamping jaw for displacing it only radially to the hollow profile axis and thus presses the clamping jaw from outside onto the hollow profile end in such a way that the latter is fixed in position. In this way, improved  
30 sealing and holding of the hollow profile end can be achieved. Counteracting the pressure force in the process is a section of an axial punch, this section plunging into the hollow profile and being part of the sealing arrangement and supporting the hollow profile  
35 end from inside against the clamping jaw pressing from outside.

The actuator results in the hollow profile end already

being clamped and thus held and sealed before the actual forming operation, so that the hollow profile blank can be moved into the forming tool when the latter is open and as a result any damage to a surface of the hollow profile blank can be avoided or at least reduced. At the same time, the hollow profile blank can be reliably held during the entire production process by being pressed against the axial punch by means of the clamping jaw acting radially from outside. As a result, this prevents a situation in which the hollow profile blank can be pulled off the axial punch during the internal high pressure forming process and thus its sealing effect is reduced or even neutralized.

Since the hollow profile blank cannot be drawn into the impression or cavity block, firstly the original overall length of the hollow profile blank remains unaffected by the forming and secondly no material of the hollow profile blank can subsequently flow from the end into the mold space, so that, in particular in the case of long forming sections, a largely uniform distribution of the wall thickness prevails at each point of the hollow profile blank.

The largely uniform distribution of the wall thickness also ensures production of a component coil without any problems, from which, after forming has been effected, a plurality of individual components of identical configuration are produced in a subsequent parting process, these individual components having identical or at least similar functional properties on account of the uniform distribution of the wall thickness.

Since, due to the device according to the invention, the hollow profile end is not changed in its shape by expansion, and at least the inside diameter is also retained, subsequent end trimming may be dispensed with, which saves production time and reduces the costs

for the entire production process.

According to the solution according to the invention,  
at least one V-ring is arranged on a side of the  
5 clamping jaw facing the hollow profile end. Due to the  
interlocking thereby achieved, not only is the hollow  
profile end held more intensely between the clamping  
jaw and the axial punch, but the axial material flow  
within the hollow profile end is interrupted, which  
10 prevents creeping of the hollow profile at its end in  
the direction of the forming tool impression. The  
result of this is that lower pressure forces have to be  
applied in order to sufficiently counter the drawing-in  
which is caused during the internal high pressure  
15 forming.

According to a preferred configuration of the  
invention, the actuator comprises at least one  
hydraulic cylinder or is formed by at least one  
20 hydraulic cylinder. As a result, the clamping jaw can  
be pressed onto the hollow profile end hydraulically  
and thus in a powerful and precise manner. At the same  
time, hydraulic cylinders constitute a drive technology  
which has proved successful for many years and is thus  
25 reliable, so that the actuator can be realized in a  
cost-effective manner with regard to operation and  
maintenance.

According to an advantageous embodiment of the  
30 invention, the actuator enables the clamping jaw to be  
displaced when the forming tool is open. The forming  
tool may be formed, for example, from at least two die  
parts which are displaceable relative to one another  
and form the impression in the closed state. Due to the  
35 displaceability of the clamping jaw when the forming  
tool is open, it is possible to move the hollow profile  
blank into the forming tool without there being a risk  
of damage to the surface of the hollow profile blank in

the process, since the two die parts lie well outside the path of movement of the hollow profile blank. Especially high quality requirements can be fulfilled by surface damage being avoided or reduced.

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The die parts can expediently be displaced while the clamping jaw fixes the hollow profile end. This results in a method advantage, since the die parts must first be displaced onto the hollow profile blank directly  
10 before the internal high pressure forming and thus premature damage to the surface of the hollow profile blank caused by a bearing surface of the cavity block can be avoided. At the same time, this prevents the end of the hollow profile blank from being drawn in as a  
15 result of preprofiling for the case where the hollow profile blank, from the closing movement of the forming tool, is to be compressed and thus preprofiled.

Further important features and advantages of the  
20 invention follow from the subclaims, from the drawings and from associated description of the figures with respect to the drawings.

It goes without saying that the abovementioned features  
25 and the features still to be explained below can be used not only in the respectively specified combination but also in other combinations or on their own without departing from the scope of the present invention.

30 Preferred exemplary embodiments of the invention are shown in the drawings and are described in more detail below, the same designations designating identical or functionally identical or similar components.

35 In the drawing:

fig. 1 shows one part of a device for internal high pressure forming in an initial position,

fig. 2 shows an illustration as in fig. 1 but with an axial punch placed against one end of a hollow profile,

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fig. 3 shows an illustration as in fig. 2 but with a clamping jaw pressed onto the end of the hollow profile from outside,

10 fig. 4 shows an illustration as in fig. 3 but with closed forming tool.

According to fig. 1, a device 10 for the internal high pressure forming of a hollow profile 5 has a cavity block 1, and adjustably mounted clamping jaw 3 arranged thereon, and an axial punch 4. In this case, the cavity block 1 is part of a forming tool (not explained in any more detail) in which the hollow profile 5 is expanded by internal high pressure and is formed in accordance with an impression 16. The clamping jaw 3 and the axial punch 4 are part of a sealing arrangement 11 which serves to hold and seal an end 12 of the hollow profile 5, this end 12 projecting from the impression 16 or cavity block 1 of the forming tool. At an end facing the hollow profile end 12, the axial punch 4 has a plunging section 6 (sealing region), with which the axial punch 4 plunges into the hollow profile 5.

In general, according to figs 1 to 4, in each case only one part of the device, for example a top part in figs 1 and 3 and a bottom part in figs 2 and 4, is shown.

The axial punch 4 widens from its plunging section 6 to the rest of the punch body in a stepped manner while forming a shoulder (not designated in any more detail), by means of which the axial punch 4 strikes the hollow profile end 12 while assuming the position of use. The plunging section 6 of the axial punch 4 is in this case



dimensioned in such a way that it comes to lie in the position of use (cf. figs 2 to 4) on a certain extension length in the forming tool. Due to the mounting thus achieved, the axial punch 4 remains  
5 oriented in a centered manner, which helps to achieve a lasting sealing function.

Running in the axial punch 4 is at least one axial action-medium passage 7, which on the one hand is  
10 connected to a unit for generating high fluid pressure and on the other hand opens out at an end face 13 of the axial punch 4. An outside diameter of the axial punch 4 on the plunging section 6 is favorably dimensioned in such a way that it corresponds to the  
15 inside diameter of the hollow profile end 12 or falls slightly below the latter, so that the section 6 comes to lie in the hollow profile end 12 free of play, but without plastic expansion of the hollow profile end 12, or with slight play.

20 According to fig. 1, the sealing arrangement 11 has at least one clamping jaw 3, which is an integral part of the forming tool and which is mounted on the outer side of the forming tool in such a way as to be displaceable  
25 radially to the hollow profile axis. At least one V-ring 2 is provided on an end face, facing the hollow profile end 12, of the clamping jaw 3, and this V-ring 2, when the clamping jaw 3 presses on the hollow profile end 12 resting in place on the plunging section  
30 6, notches and fixes said hollow profile end 12. The notch produced by the V-ring 2 can be advantageously used, for example, during further use of the hollow profile 5 in an operation for joining it to other components.

35 According to the invention, an actuator 14 is provided for actuating the clamping jaw 3 (cf. figs 3 and 4) and drives the latter for displacing it only radially

relative to the hollow profile axis. In this case, the actuator 14 may be formed by at least one hydraulic cylinder or may comprise at least one hydraulic cylinder. Alternatively, it is also conceivable for the  
5 actuator 14 to be formed by at least one electric motor or to comprise at least one electric motor.

In general, the device 2 has at least two die parts 15 adjustable relative to one another, for example a top  
10 die part 15' and a bottom die part 15'', which can be displaced toward and away from one another independently of the clamping jaw 3. According to figs 1 to 3, it is shown that the actuator 14 enables the clamping jaw 3 to be displaced when the forming tool is  
15 open.

In order to enable the clamping jaw 3 to be displaced independently of the die part 15, the clamping jaw 3, according to fig. 3, can be supported for example on  
20 the forming tool, that is to say on the die part 15', whereas the die part 15' is supported on a foundation 9.

However, it is also conceivable, according to fig. 4, for both the clamping jaw 3 and the die part 15' of the  
25 forming tool to be supported independently of one another on the foundation 9.

In principle, it is conceivable for the clamping jaws 3 to be carried along axially. This ensures controllable  
30 subsequent feeding of material during the forming process, as a result of which the quality of the hollow profile 5 produced can be increased. In the process, the clamping jaws 3 may either be carried along  
35 passively or via a, for example power-controlled, actuator (not shown), which permits a displacement of the clamping jaws 3 with respect to the die parts 15 axially relative to the hollow profile 5.

The method sequence during the clamping or internal high pressure forming process is to be explained briefly below:

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At the start of the method, the hollow profile 5 is inserted into the bottom die 15'' of the forming tool, whereupon the section 6 of the axial punch 4, according to fig. 1, is pushed in the direction of movement 8 into both ends, here into the end 12 of the hollow profile 5, until its shoulder strikes the hollow profile end 12. Alternatively, it is conceivable for the plunging section 6 to be pushed into the hollow profile 5 beforehand and for the latter to then be displaced between the two die parts 15' and 15''.

After that, in a second method step according to fig. 2, the clamping jaw 3 is pressed radially from outside onto the hollow profile end 12 by means of the actuator 14 and thus fixes the latter in position on the plunging section 6 of the axial punch 4. Due to the movement of the clamping jaw 3 in the direction of movement 8' toward the hollow profile end 12, the latter is notched by the V-ring 2 due to the pressure force exerted by the actuator 14. In general, it is conceivable for the actuator 14 for displacing the die parts 15' and 15'' or the clamping jaws 3 to be designed as a hydraulic or electromechanical actuator.

The embodiment of the V-ring 2 shown according to figs 1 to 4 represents only one possible variant, clamping jaws 3 without V-rings 2 also being conceivable. In this case, the clamping jaw 3 is connected frictionally to the hollow profile end 12, with an interference fit being formed, and is thus sealed.

According to fig. 3, the clamping operation and thus the sealing operation by the clamping jaw 3 being

pressed radially onto the hollow profile end 12 has been completed and the hollow profile 5 is fixed in position in the device 10. The die part 15' is now displaced toward the hollow profile 5 in the direction of movement 8'' by the actuator 14'. It is conceivable here for either only the top die part 15' or else the top and the bottom die part 15', 15'' to perform a closing movement. The two die parts 15' and 15'' are displaced toward one another until the two die parts 15', 15'' outside the impression 16 come to lie on the hollow profile 5. In the process, the die parts 15' and 15'' are displaced, while the clamping jaw 3 fixes the hollow profile end 12. The clamping effect of the clamping jaws 3 prevents the hollow profile end 12 from being drawn into the impression 16 by the top die part 15' during the closing movement.

According to fig. 4, the closing operation of the forming tool has now been completed, so that the hollow profile 5, by means of the unit for generating high fluid pressure, can be filled with a pressure fluid via the at least one action-medium passage 7. After that, the pressure fluid is put under an internal high pressure, as a result of which the hollow profile 5 expands and comes into contact with the inner wall of the impression 16 in such a way as to conform to the contour. During the expansion, the clamping jaws 3 prevent the hollow profile end 12 from being drawn into the impression 16 and at the same time seal the hollow profile end 12. After the internal high pressure forming has been effected, first the die parts 15' and 15'' and then the clamping jaws 3 are retracted or opened, so that the finish-formed hollow profile 5 can be removed by withdrawal of the axial punch 4.